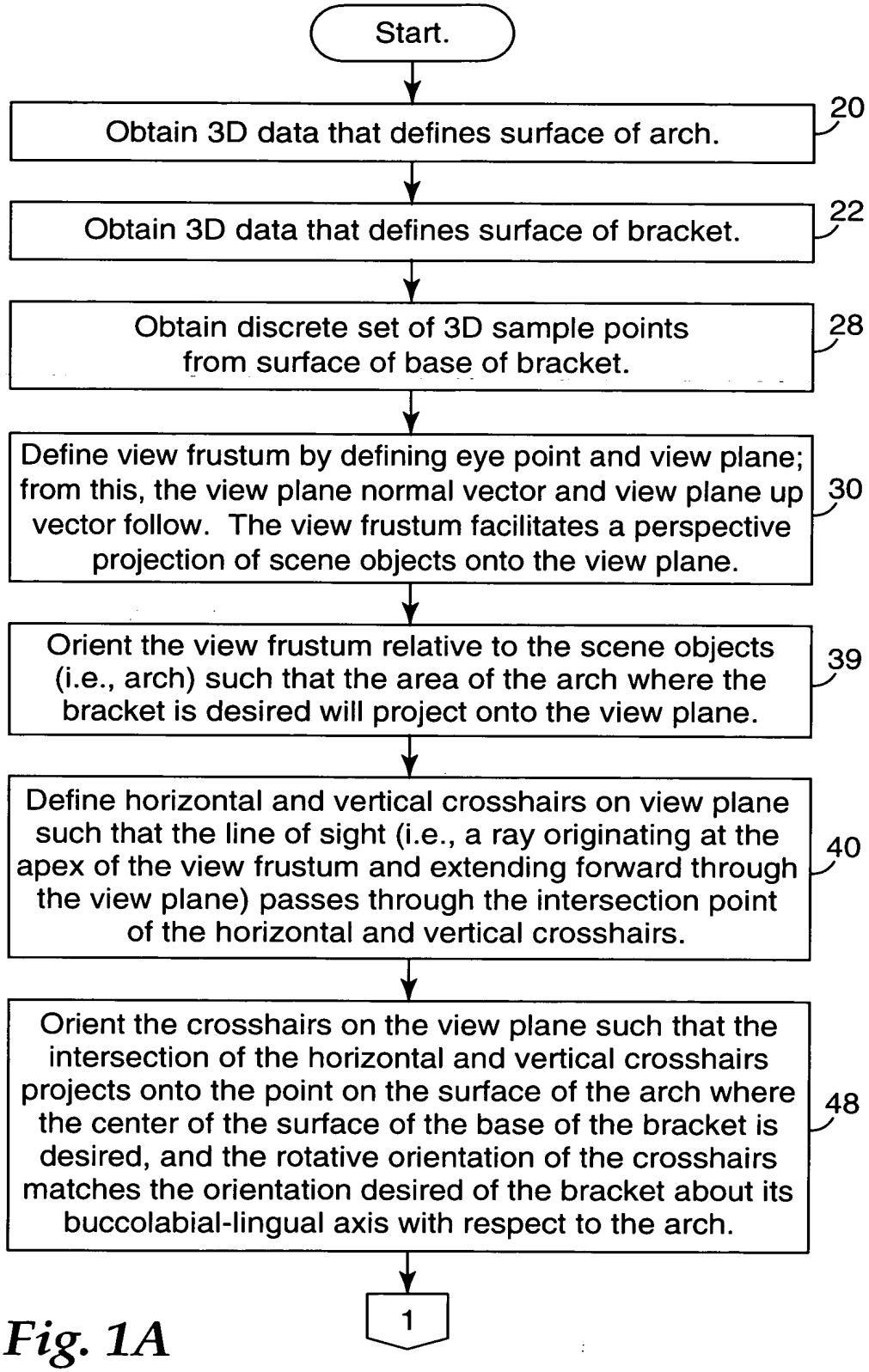
Start.
Obtain 3D data that defines surface of arch.
20
Obtain 3D data that defines surface of bracket.
22
Obtain discrete set of 3D sample points from surface of base of bracket.
28
Define view frustum by defining eye point and view plane; from this, the view plane normal vector and view plane up vector follow. The view frustum facilitates a perspective projection of scene objects onto the view plane.
30
Orient the view frustum relative to the scene objects (i.e., arch) such that the area of the arch where the bracket is desired will project onto the view plane.
39
Define horizontal and vertical crosshairs on view plane such that the line of sight (i.e., a ray originating at the apex of the view frustum and extending forward through the view plane) passes through the intersection point of the horizontal and vertical crosshairs.
40
Orient the crosshairs on the view plane such that the intersection of the horizontal and vertical crosshairs projects onto the point on the surface of the arch where the center of the surface of the base of the bracket is desired, and the rotative orientation of the crosshairs matches the orientation desired of the bracket about its buccolabial-lingual axis with respect to the arch.
48
1

Fig. 1A

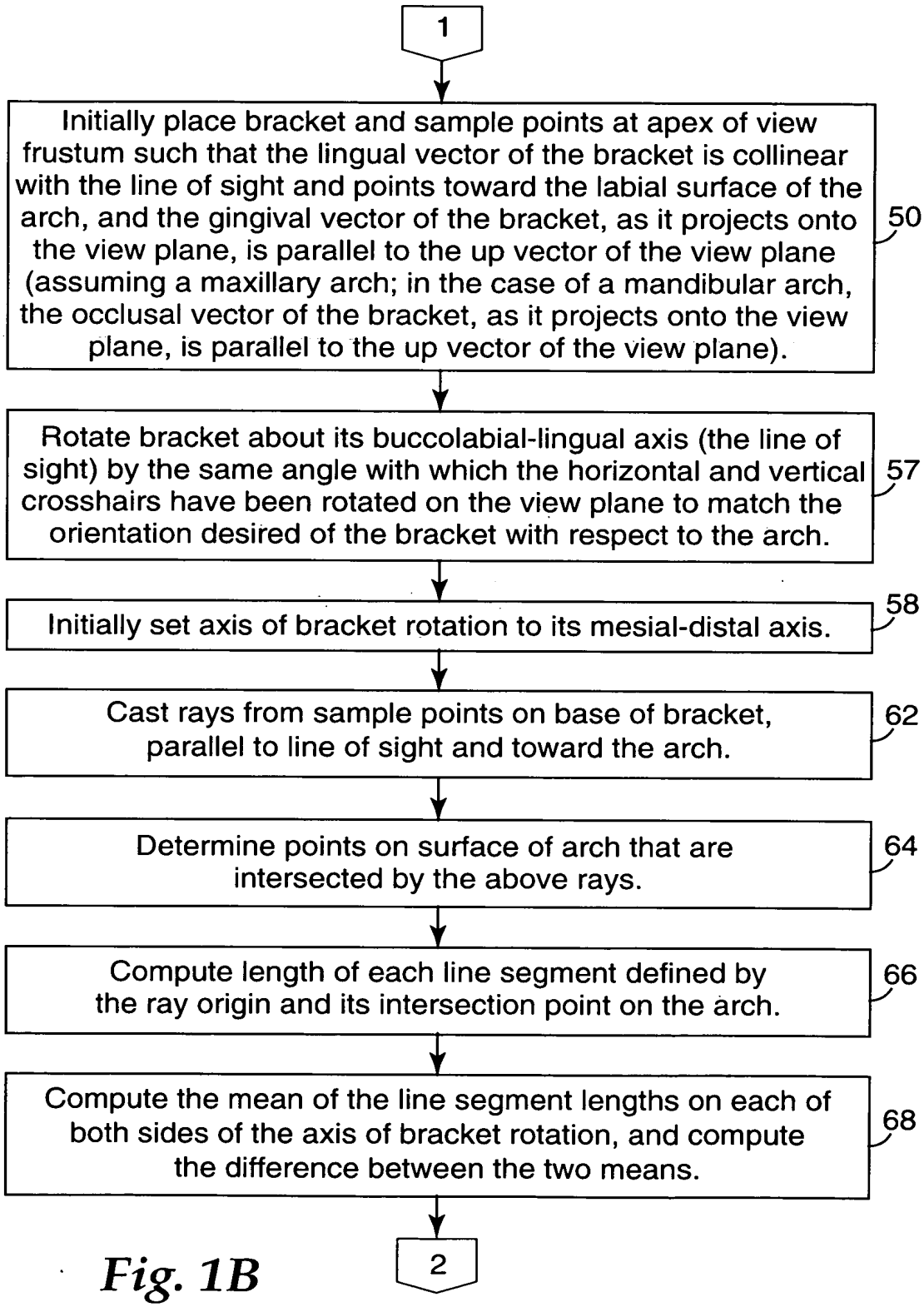
1
Initially place bracket and sample points at apex of view frustum such that the lingual vector of the bracket is collinear with the line of sight and points toward the labial surface of the arch, and the gingival vector of the bracket, as it projects onto the view plane, is parallel to the up vector of the view plane (assuming a maxillary arch; in the case of a mandibular arch, the occlusal vector of the bracket, as it projects onto the view plane, is parallel to the up vector of the view plane).
50
Rotate bracket about its buccolabial-lingual axis (the line of sight) by the same angle with which the horizontal and vertical crosshairs have been rotated on the view plane to match the orientation desired of the bracket with respect to the arch.
57
Initially set axis of bracket rotation to its mesial-distal axis.
58
Cast rays from sample points on base of bracket, parallel to line of sight and toward the arch.
62
Determine points on surface of arch that are intersected by the above rays.
64
Compute length of each line segment defined by the ray origin and its intersection point on the arch.
66
Compute the mean of the line segment lengths on each of both sides of the axis of bracket rotation, and compute the difference between the two means.
68
2

Fig. 1B

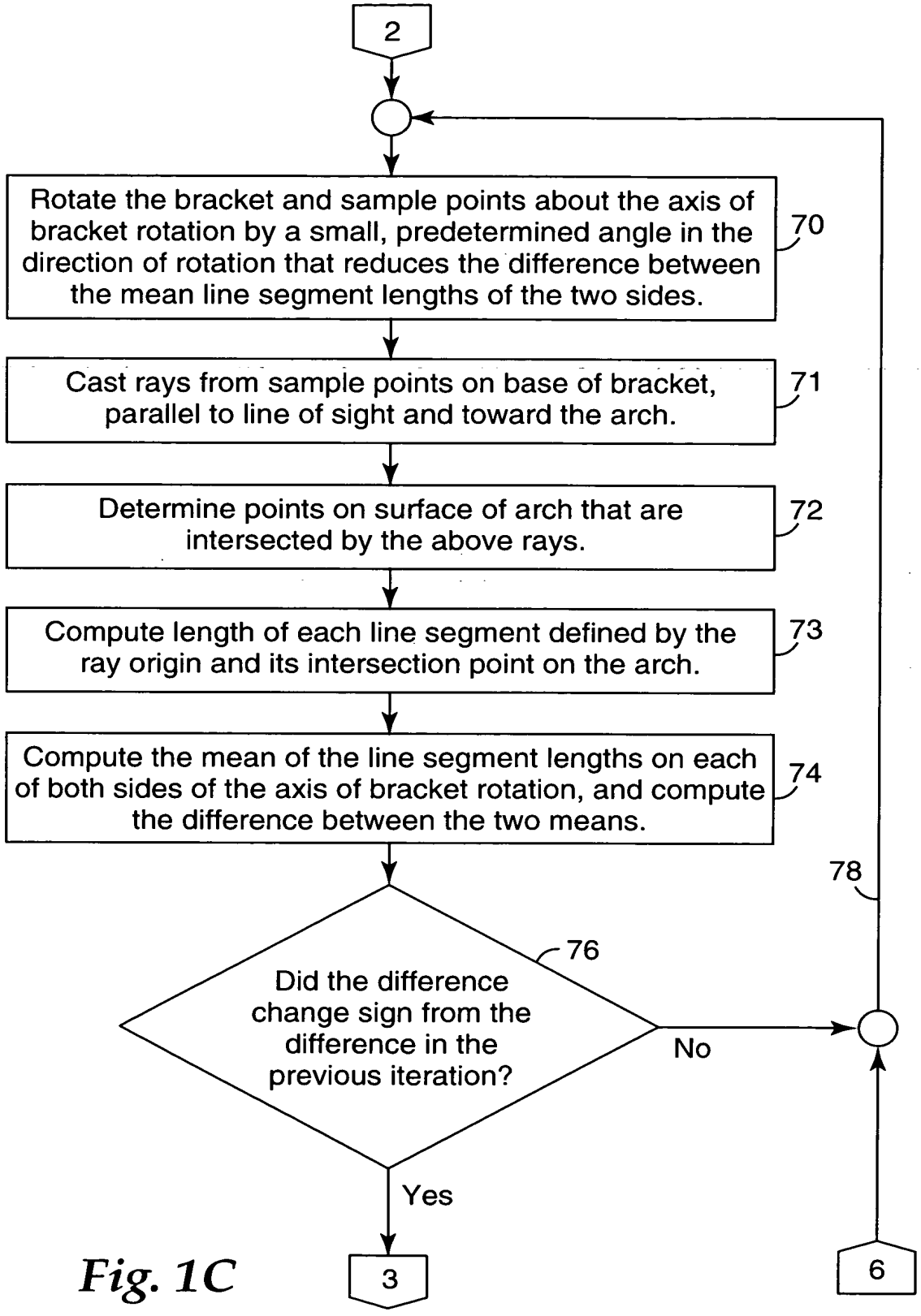
2
Rotate the bracket and sample points about the axis of bracket rotation by a small, predetermined angle in the direction of rotation that reduces the difference between the mean line segment lengths of the two sides.
70
Cast rays from sample points on base of bracket, parallel to line of sight and toward the arch.
71
Determine points on surface of arch that are intersected by the above rays.
72
Compute length of each line segment defined by the ray origin and its intersection point on the arch.
73
Compute the mean of the line segment lengths on each of both sides of the axis of bracket rotation, and compute the difference between the two means.
74
78
76
Did the difference change sign from the difference in the previous iteration?
No
Yes
3
6

Fig. 1C

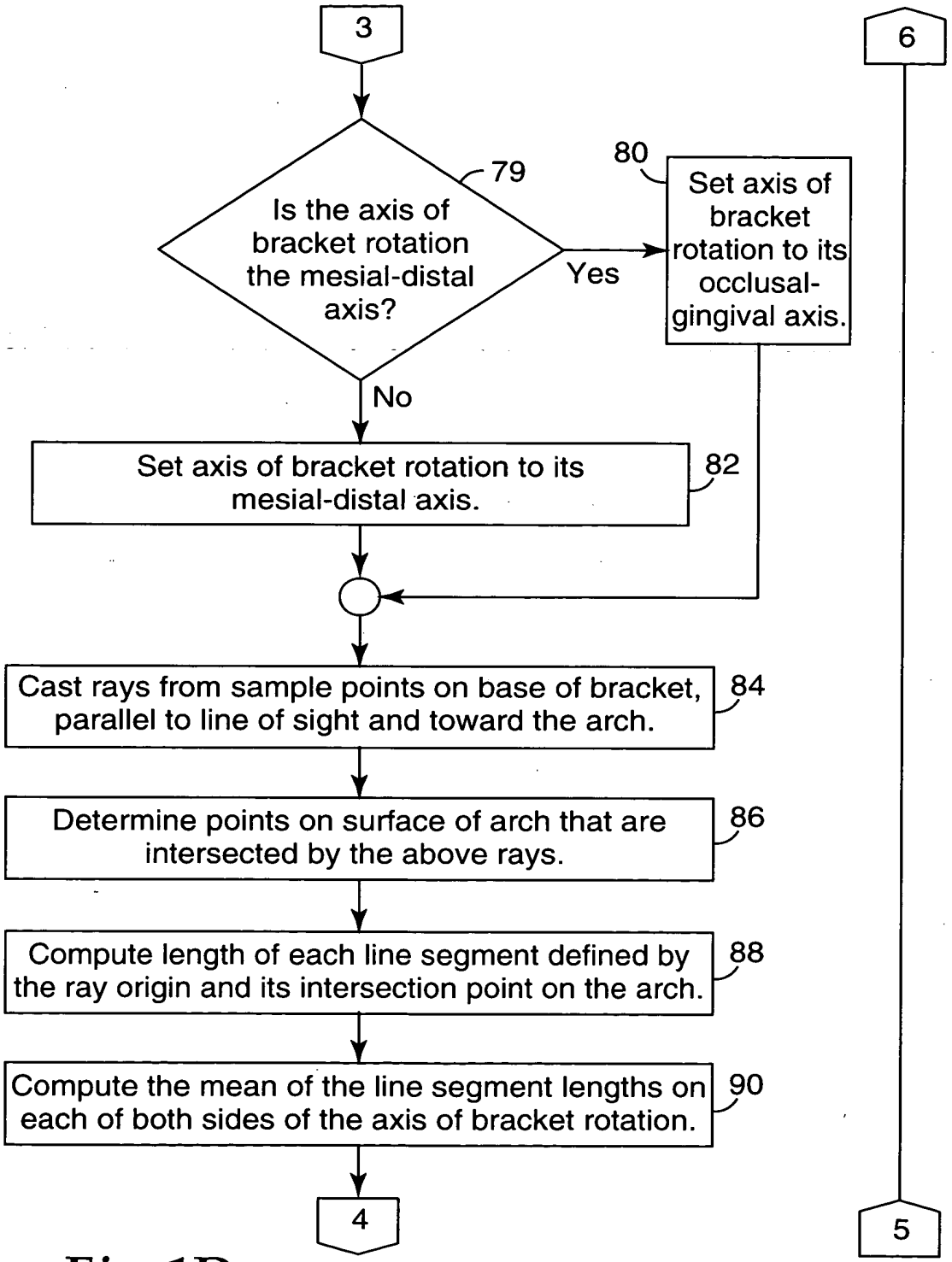
3
6
79
Is the axis of bracket rotation the mesial-distal axis?
80
Set axis of bracket rotation to its occlusal-gingival axis.
Yes
No
Set axis of bracket rotation to its mesial-distal axis.
82
Cast rays from sample points on base of bracket, parallel to line of sight and toward the arch.
84
Determine points on surface of arch that are intersected by the above rays.
86
Compute length of each line segment defined by the ray origin and its intersection point on the arch.
88
Compute the mean of the line segment lengths on each of both sides of the axis of bracket rotation.
90
4
5

Fig. 1D

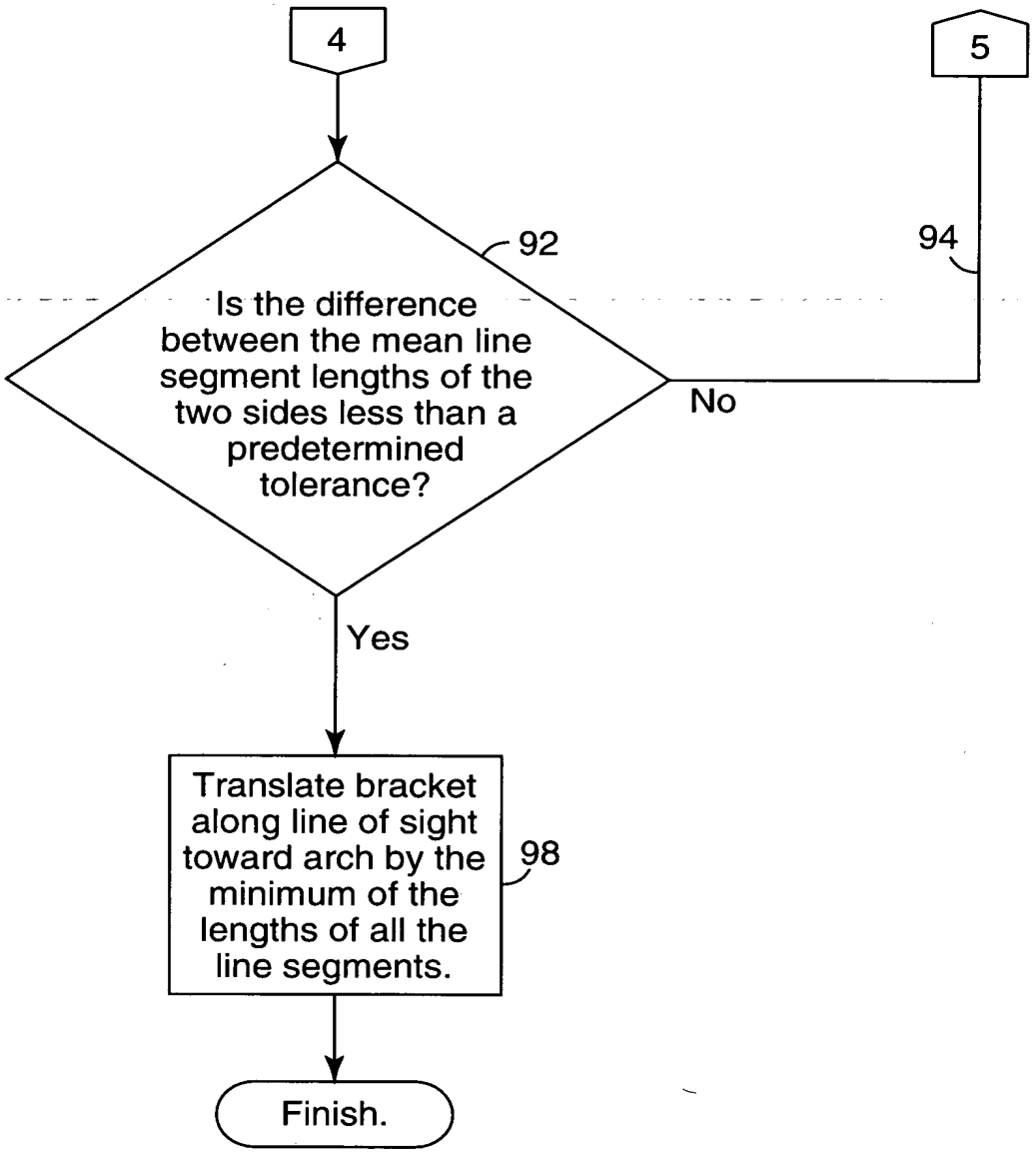
4
5
92
94
Is the difference between the mean line segment lengths of the two sides less than a predetermined tolerance?
No
Yes
Translate bracket along line of sight toward arch by the minimum of the lengths of all the line segments.
98
Finish.

Fig. 1E

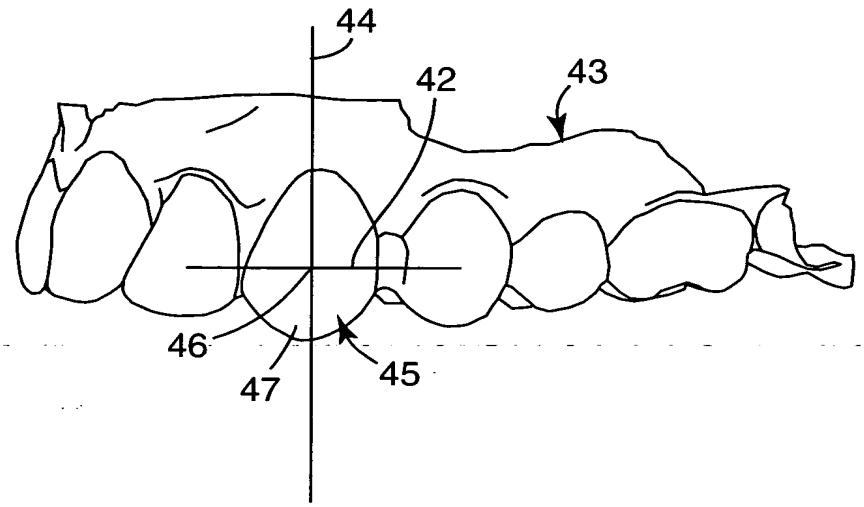

Fig. 2

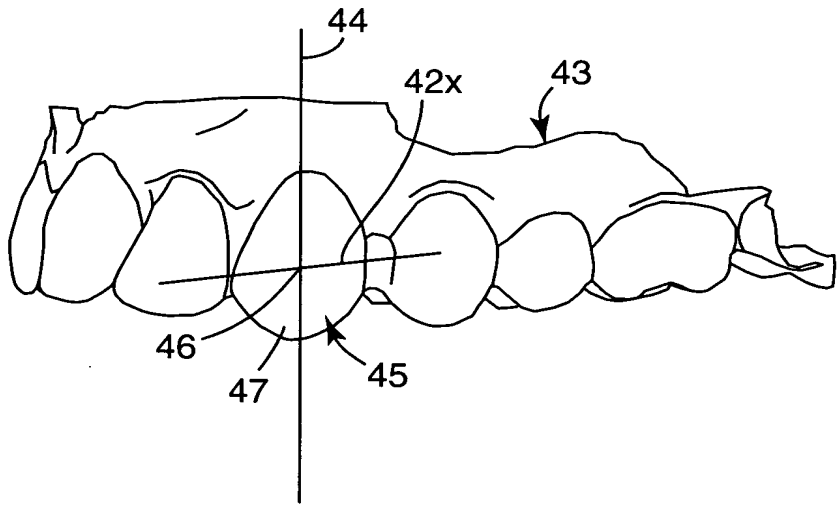

Fig. 2A

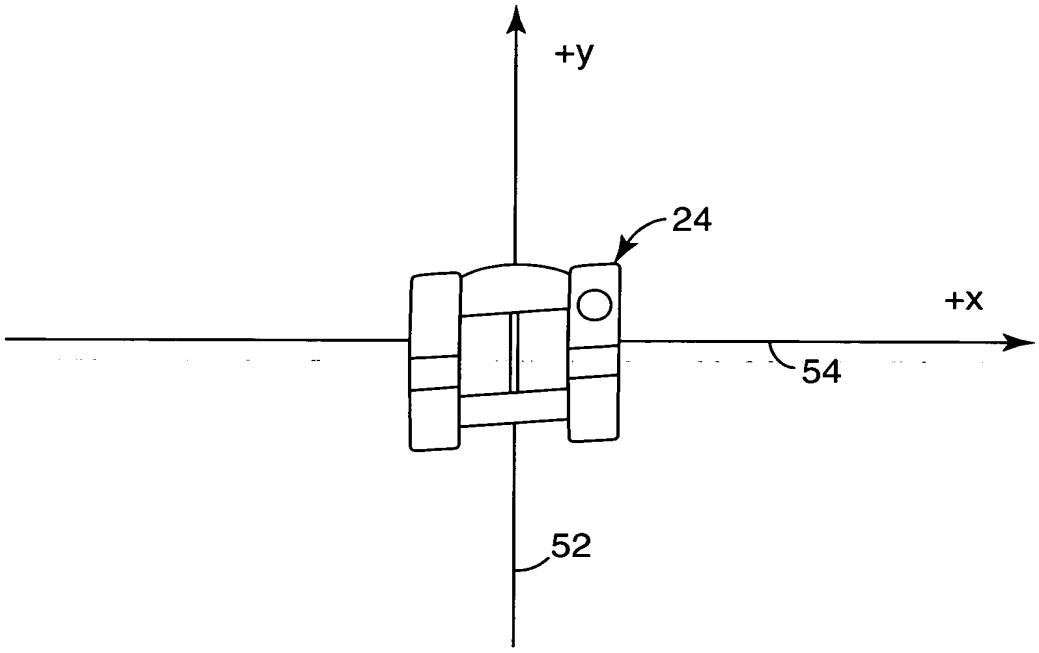

Fig. 3

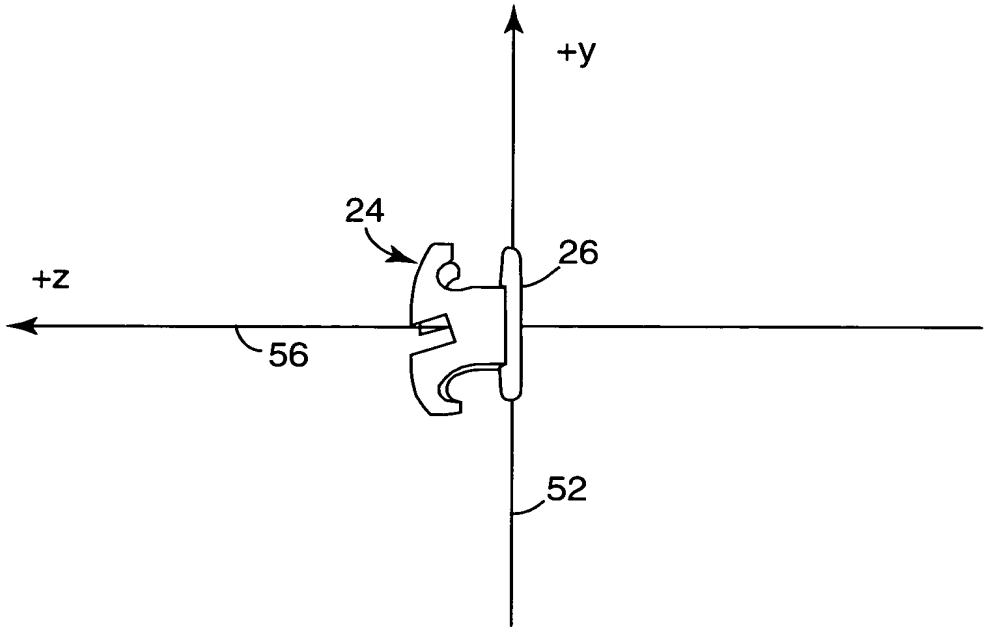

Fig. 4

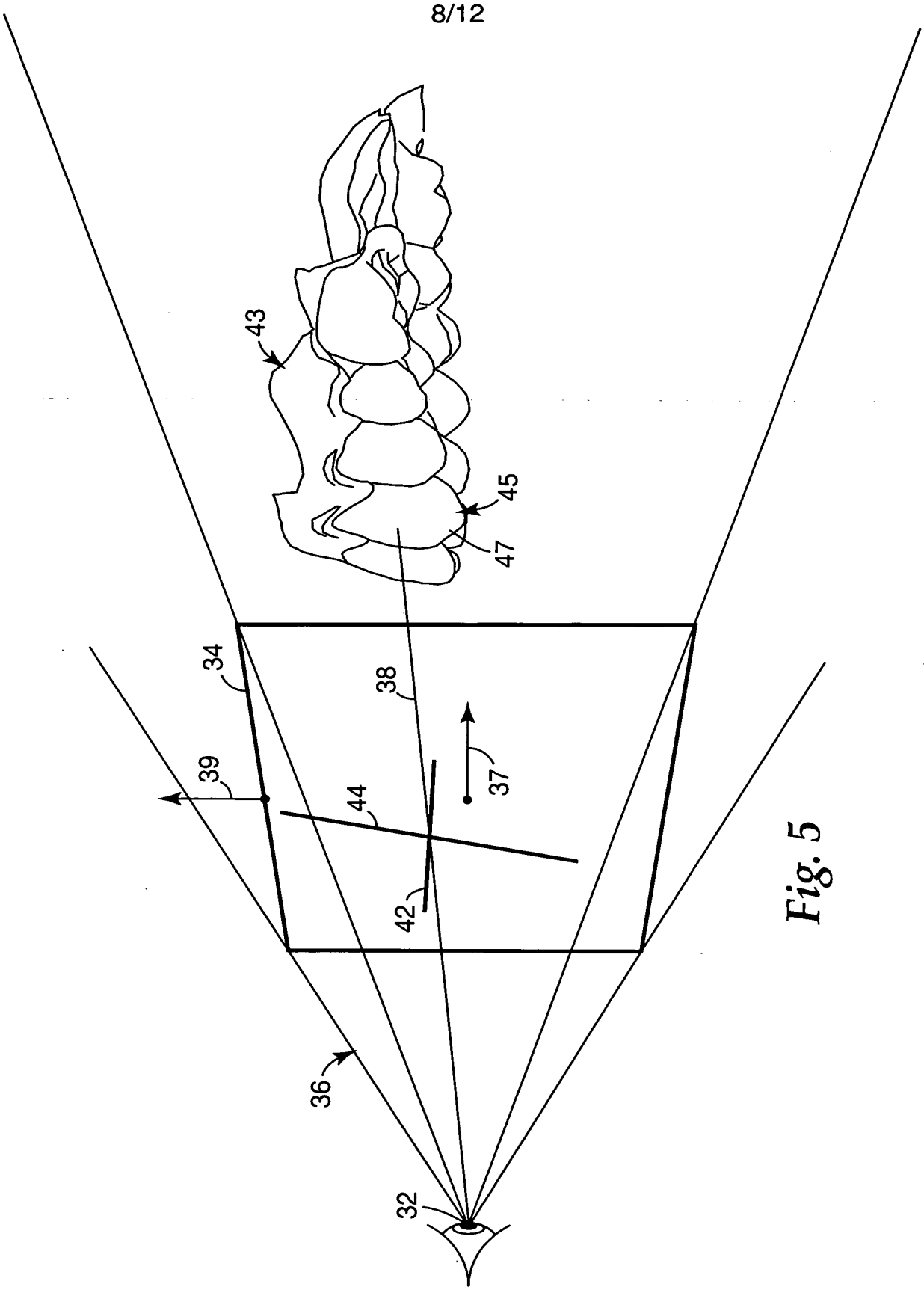

Fig. 5

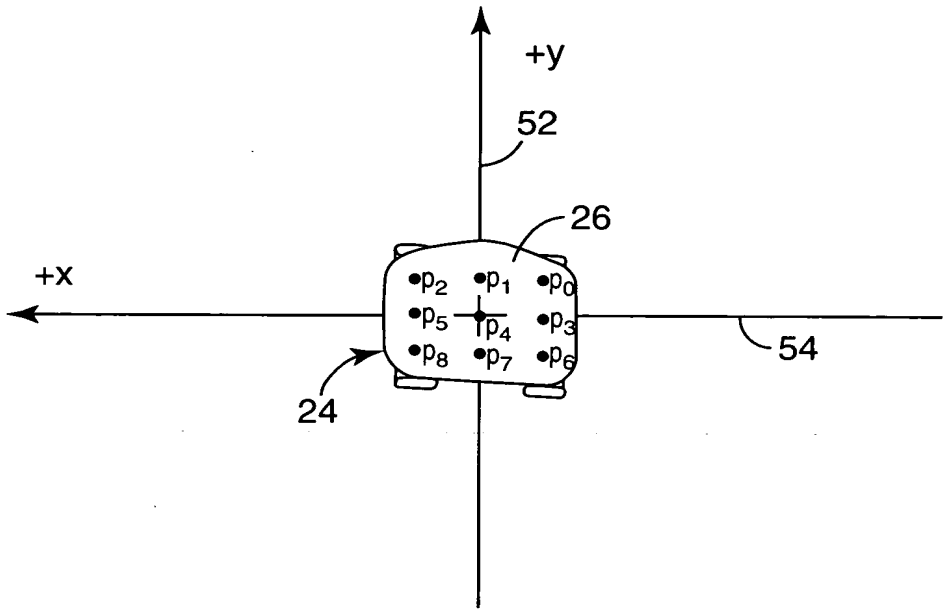
+y
52
26
+x
p_2 p_1 p_0
p_5 p_4 p_3
p_8 p_7 p_6
54
24

Fig. 6

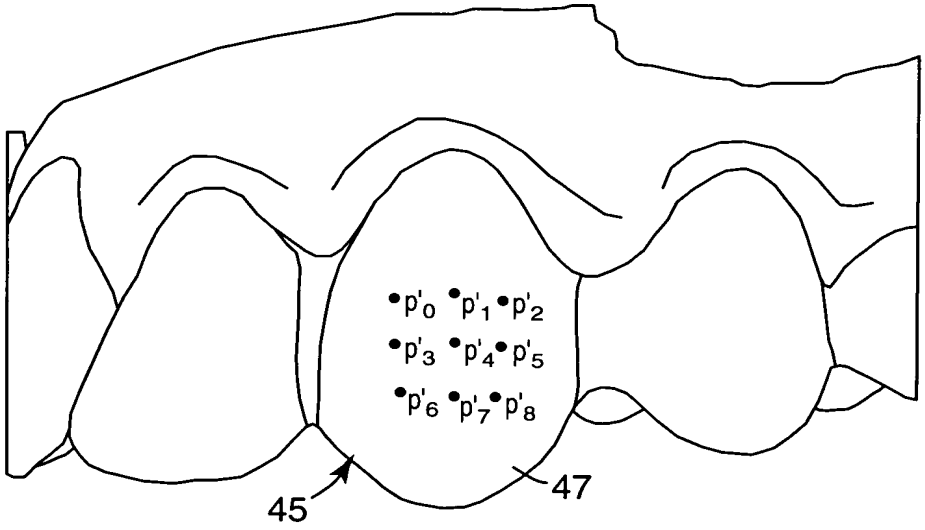
p'_0 p'_1 p'_2
p'_3 p'_4 p'_5
p'_6 p'_7 p'_8
45
47

Fig. 7

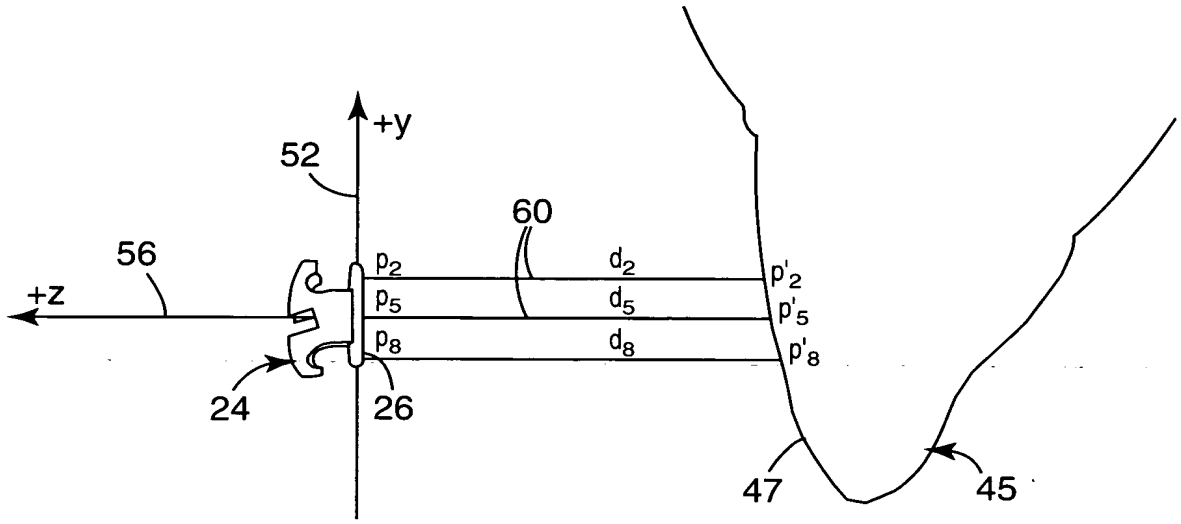
+y
52
60
56
+z
p_2
p_5
p_8
d_2
d_5
d_8
p'_2
p'_5
p'_8
24
26
47
45

Fig. 8

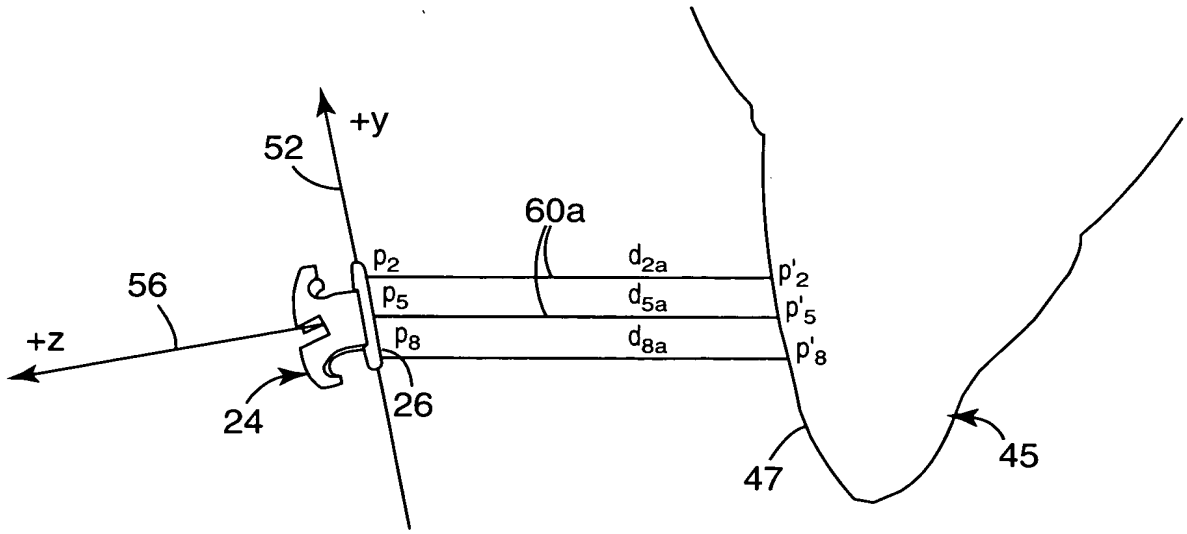
+y
52
60a
56
+z
p_2
p_5
p_8
d_{2a}
d_{5a}
d_{8a}
p'_2
p'_5
p'_8
24
26
47
45

Fig. 9

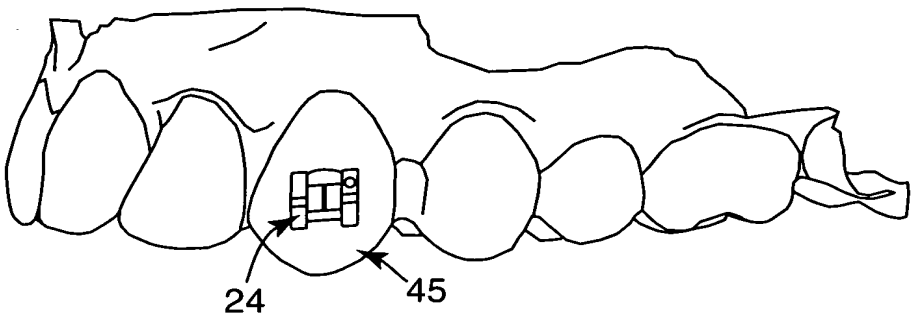

Fig. 10

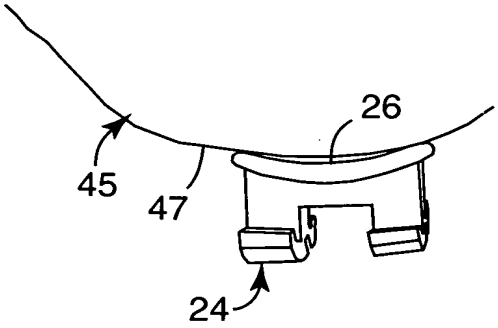

Fig. 11

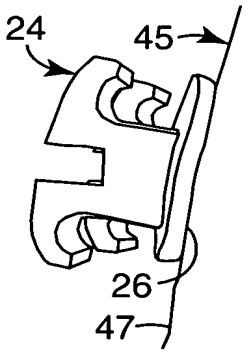

Fig. 12

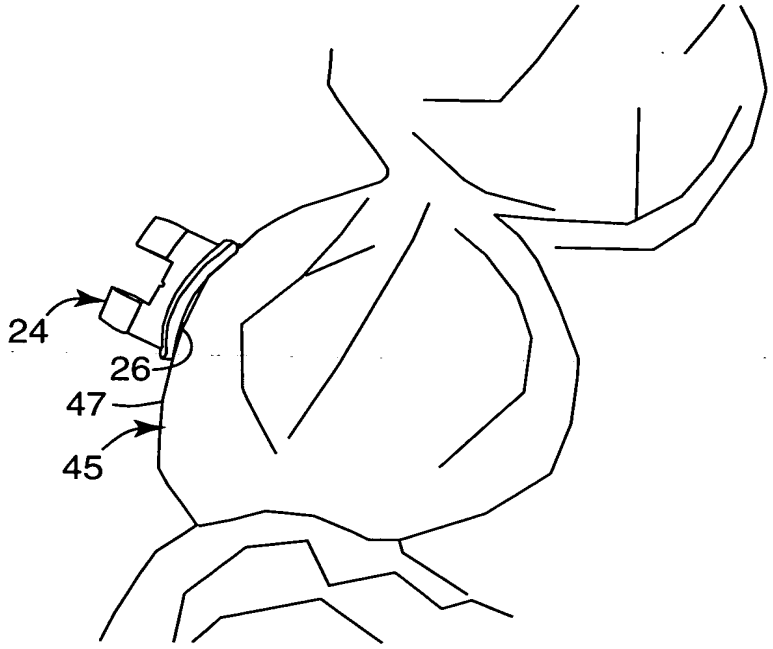

Fig. 13

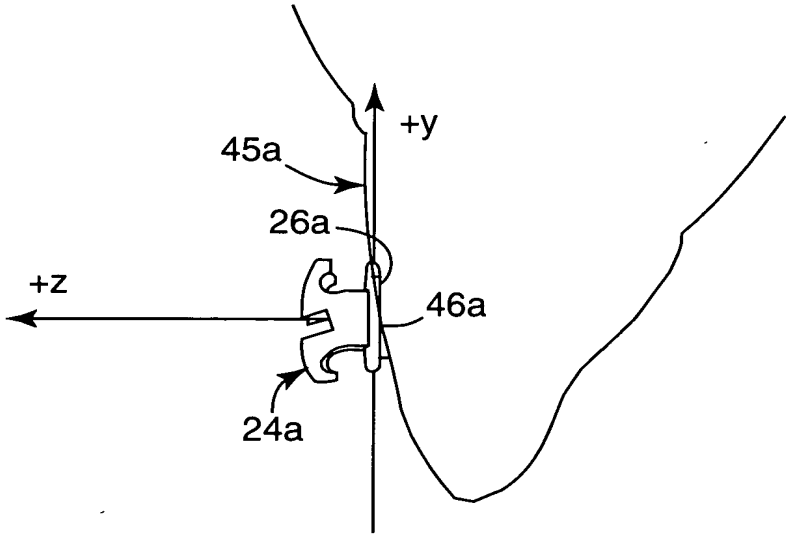

Fig. 14